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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/732,177	12/07/2000	Kenichi Hasegawa	116-002064	1420

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EXAMINER	
SHARON, AYAL I	
ART UNIT	PAPER NUMBER
2123	

DATE MAILED: 02/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/732,177	HASEGAWA, KENICHI	
	Examiner	Art Unit	
	Ayal I Sharon	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 November 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-12* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-12* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☒ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Introduction

1. Claims 1-12 of U.S. Application 09/732,177 originally filed on 12/07/2000 are presented for examination. In the RCE filed on 11/15/2004, Applicant has amended independent claims 1 and 7.

Priority

2. Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Japan on 12/07/1999. It is noted, however, that applicant has not filed a certified copy of the Japanese application as required by 35 U.S.C. 119(b).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The prior art used for these rejections is as follows:

5. Schenck, J.F. et al. "Formulation of Design Rules for NMR Imaging Coil by Using Symbolic Manipulation." Proc. of the 4th ACM Symposium on Symbolic and Algebraic Computation. 1981. pp.85-93. (Henceforth referred to as "**Schenck**").
6. Kiyoshi, T. et al. "Development of 1 GHz Superconducting NMR Magnet at TML/NRIM." IEEE Transactions on Applied Superconductivity. Vol.9, Issue 2. pp.1051-8223. Meeting Date: 9/13/1998 – 9/18/1998. Publication Date: June 1999. (Henceforth referred to as "**Kiyoshi**").
7. Ishibashi, K. "Nonlinear Eddy Current Analysis by the Integral Equation Method." IEEE Transactions on Magnetics. Sept. 1994. Vol. 30, Issue 5. pp.3020-3023. (Henceforth referred to as "**Ishibashi**").
8. The claim rejections are hereby summarized for Applicant's convenience. The detailed rejections follow.
9. **Claims 1-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schenck in view of Kiyoshi, and further in view of Ishibashi.**
10. In regards to claim 1: 1. A method of designing a magnetic field gradient coil assembly using tightly wound inner and outer coils, said method comprising the steps of:

setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

setting or resetting the number of said outer coils and the number of turns of each outer coil;

calculating Fourier components of an electric current spatial distribution necessary for the outer coils;

optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

calculating magnetic fields leaking from the inner and outer coils, respectively;

calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields; and

resetting the number of the outer coils and the number of turns of each outer coil such that the magnetic field distortions caused by eddy currents fall within a tolerable range.

Schenck teaches a method of designing a magnetic field gradient coil assembly using coils "... that will produce a given magnetic field." (Schenck, p.85, 1st para.). Schenck also teaches that "the natural mathematical approach to this problem is to introduce some form of series expansion of the field, wherein the expansion coefficients are functions of the configuration of the coil." (Schenck, p.85, col.1, 2nd para.).

However, Shenck does not expressly teach:

1) the use of inner and outer coils,

2) that the resulting field strength "falls within a tolerable range of a target magnetic field gradient under shielded conditions", as claimed,

3) setting a number of inner or outer coils, nor the number of turns of each coil,

4) the use of Fourier components,

5) the calculation of leaking fields,

6) field distortions caused by eddy currents, nor

7) resetting the number of outer coils and number of turns of each outer coil if the magnetic field distortions are outside the tolerable range.

Kiyoshi, on the other hand, expressly teaches feature (1): the use of inner and outer coils (See Abstract: "The outer magnet of LTS coils ... The inner coil ..." See also Fig.1, showing both the Outer Magnet and the Inner Coil.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Kiyoshi, because both relate to the design of NMR magnets and coils. For example,

Kiyoshi expressly teaches (see Abstract): "As a high-resolution NMR magnet, field stability as well as field homogeneity is very important, which is especially difficult to achieve in the inner coil when exposed to extremely high magnetic fields that superconducting magnets have not yet encountered."

Ishibashi expressly teaches the features (2) –(7) listed immediately above (See Ishibashi, Abstract and "I. Introduction"). More specifically, Ishibashi teaches "surface magnetic fields given as boundary values". This is feature (2). Ishibashi also teaches that "...the quantities are expanded by Fourier series..." This is feature (4). Ishibashi also teaches "surface and internal [magnetic] fields", that are equivalent to the "leaked fields" in feature (5). Ishibashi also teaches the field effects of eddy currents. This is feature (6).

Ishibashi also teaches that the technique is "iterative". (See Ishibashi, "I. Introduction"), therefore teaching the "setting" and "resetting" components of features (3) and (7) listed immediately above. Moreover, it is inherent that the number of coils, and the number of turns per coil, will have an effect on the EMF, and therefore that these will be the parameters that are adjusted.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

11. In regards to claim 2:

> 2. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions uses a Green function.

Schenck does not expressly teach the use of Green's theorem in order to set, reset, and optimize the positions of the inner coils.

Ishibashi, on the other hand, does expressly teach this. (See Ishibashi, Abstract, "I. Introduction").

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

12. In regards to claim 3:

> 3. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of calculating Fourier components of an electric current distribution necessary for the outer coils uses a Green function.

Schenck does not expressly teach the use of Green's theorem in order to set, reset, and optimize the positions of the outer coils.

Ishibashi, on the other hand, does expressly teach this. (See Ishibashi, Abstract, "I. Introduction").

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for

analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

13. In regards to claim 4:

> 4. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution performs the approximation using a small number of tightly wound coils.

While Schenck teaches that "... the natural mathematical approach to this problem is to introduce some form of series expansion of the field, wherein the expansion coefficients are functions of configuration of the coil." (See Schenck, p.85, col.1, 2nd para.). However, Schenck does not expressly teach the use of the Fourier series or Fourier components.

Ishibashi, on the other hand, does expressly teach the use of Fourier series, to model the "periodic electromagnetic quantities in the conductor". (See Ishibashi, Abstract, "I. Introduction"). It is inherent in a Fourier series that each additional element produces diminishing improvements in the results.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

14. In regards to claim 5:

5. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields use a Green function.

Schenck does not expressly teach the use of Green's theorem in order to calculate magnetic field distortions caused by eddy currents.

Ishibashi, on the other hand, does expressly teach this. (See Ishibashi, Abstract, "I. Introduction").

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

15. In regards to claim 6: 6. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range, said step of calculating Fourier components of an electric current distribution necessary for the outer coils, said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution, said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields are repeatedly carried out to determine optimum conditions for the outer coils by trial and error.

Schenck does not expressly teach that the steps are repeatedly carried out to determine the optimum conditions.

Ishibashi, however, teaches that the technique is "iterative". (See Ishibashi, "I. Introduction").

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi

because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

16. In regards to claim 7: 7. A magnetic field gradient coil assembly having tightly wound inner and outer coils, said magnetic field gradient coil assembly having been designed by a method comprising the steps of:

setting or resetting the number of said inner coils and the number of turns of each inner coil and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

setting the number of said outer coils and the number of turns of each outer coil;

calculating Fourier components of an electric current spatial distribution necessary for the outer coils;

optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

calculating magnetic fields leaking from the inner and outer coils, respectively;

calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields; and

resetting the number of the outer coils and the number of turns of each outer coil such that the magnetic field distortions caused by eddy currents fall within a tolerable range.

Schenck teaches a method of designing a magnetic field gradient coil assembly using coils "... that will produce a given magnetic field." (Schenck, p.85, 1st para.). Schenck also teaches that "the natural mathematical approach to this problem is to introduce some form of series expansion of the field, wherein the expansion coefficients are functions of the configuration of the coil." (Schenck, p.85, col.1, 2nd para.).

However, Shenck does not expressly teach:

1) the use of inner and outer coils,

2) that the resulting field strength "falls within a tolerable range of a target magnetic field gradient under shielded conditions", as claimed,

3) setting a number of inner or outer coils, nor the number of turns of each coil,

4) the use of Fourier components,

5) the calculation of leaking fields,

6) field distortions caused by eddy currents, nor

7) resetting the number of outer coils and number of turns of each outer coil if the magnetic field distortions are outside the tolerable range.

Kiyoshi, on the other hand, expressly teaches feature (1): the use of inner and outer coils (See Abstract: "The outer magnet of LTS coils ... The inner coil ..." See also Fig.1, showing both the Outer Magnet and the Inner Coil.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Kiyoshi, because both relate to the design of NMR magnets and coils. For example, Kiyoshi expressly teaches (see Abstract): "As a high-resolution NMR magnet, field stability as well as field homogeneity is very important, which is especially difficult to achieve in the inner coil when exposed to extremely high magnetic fields that superconducting magnets have not yet encountered."

In addition, Ishibashi expressly teach the features (2) –(7) listed immediately above (See Ishibashi, Abstract and "I. Introduction"). More specifically, Ishibashi teaches "surface magnetic fields given as boundary values". This is feature (2). Ishibashi also teaches that "...the quantities are expanded by Fourier series..." This is feature (4). Ishibashi also teaches "surface

and internal [magnetic] fields", that are equivalent to the "leaked fields" in feature (5). Ishibashi also teaches the field effects of eddy currents. This is feature (6).

Ishibashi also teaches that the technique is "iterative". (See Ishibashi, "I. Introduction"), therefore teaching the "setting" and "resetting" components of features (3) and (7) listed immediately above. Moreover, it is inherent that the number of coils, and the number of turns per coil, will have an effect on the EMF, and therefore that these will be the parameters that are adjusted.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck with those of Ishibashi because "the boundary element method (BEM) has been widely used for analyzing open boundary eddy current problems" and "... it is well known that even BEM can be applied to the analysis of nonlinear problems." (See Ishibashi, "I. Introduction").

17. **Claims 8-12 are rejected based on the same reasoning as claims 2-6. Claims 8-12 are magnetic field gradient coil assembly claims reciting the equivalent limitations as are recited in method claims 2-6 and taught throughout Schenck and Ishibashi.**

Response to Amendment

Re: Objections

18. Applicant's amendments to claims 1 and 7 have overcome the objections based on spelling errors in those claims. The objections have been withdrawn.

Re: Claim Rejections - 35 USC § 103

19. The Applicant argues (RCE filed 11/15/2004, p.6) that:

> Specifically, equations 5 and 6 of the Ishibashi publication disclose calculating magnetic fields caused by non-linear eddy currents by using Fourier transformation along temporal axis. In contrast, claims 1 and 7 have been amended to recite "calculating Fourier components of an electrical current spatial distribution ...". Support for this amendment to claims 1 and 7 is found in equations 26 and 27 of the applications as originally filed.

Examiner respectfully disagrees with Applicant's characterization of equation 5 of the Ishibashi publication. The variables E_i, H_i, and B_i are integrated over the variable "k", (as in $\Sigma^{\infty}{}_{k=-\infty}$) and not over the variable "t", which represents time (or "temporal axis"). Examiner notes that Applicant also uses the variable "k" in the above cited equations 26 and 27 of the specification as originally filed. Therefore Examiner finds that Ishibashi does teach "... calculating Fourier components of an electrical current spatial distribution ...".

20. The Applicant also argues (RCE filed 11/15/2004, p.7) that:

> The Schenck et al. publication discloses utilizing a boundary element method (BEM) to design a current carrying coil that will produce a given magnètic field. In contrast, the present invention does not utilize BEM.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., not utilizing BEM) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Moreover, Applicant has not explained why the lack of a feature is an improvement over the prior art, as opposed to a step back in the art.

21. The Applicant also requested (RCE filed 11/15/2004, p.7) that:

> Moreover, in the Office Action, the Examiner takes official notice "that it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Schenck by using inner and outer coils, (as claimed in feature 1 of the list of features not taught by Schenck), because doing so would enable creating EMF patterns that cannot be created by using only one layer of coils." Reconsideration of this official notice is requested.

Examiner has replaced the Official Notice elements in the rejections with the Kiyoshi reference.

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ayal I. Sharon whose telephone number is (703) 306-0297. The examiner can normally be reached on Monday through Thursday, and the first Friday of a biweek, 8:30 am – 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska can be reached on (703) 305-9704. Any response to this office action should be mailed to:

Director of Patents and Trademarks
Washington, DC 20231

Hand-delivered responses should be brought to the following office:

4th floor receptionist's office
Crystal Park 2
2121 Crystal Drive
Arlington, VA

The fax phone numbers for the organization where this application or proceeding is assigned are:

All communications: (703) 872-9306

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist, whose telephone number is: (703) 305-3900.

Ayal I. Sharon

Art Unit 2123

January 27, 2005

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER